

### **In the Specification:**

On page 1 after the title and before paragraph 0001, insert the following new paragraphs and headings as follows:

Applicant claims, under 35 U.S.C. §§ 120 and 365, the benefit of priority of the filing date of June 27, 2003 of a Patent Cooperation Treaty patent application, copy attached, Serial Number PCT/EP2003/006845, filed on the aforementioned date, the entire contents of which are incorporated herein by reference, wherein Patent Cooperation Treaty patent application Serial Number PCT/EP2003/006845 was not published under PCT Article 21(2) in English.

Applicant claims, under 35 U.S.C. § 119, the benefit of priority of the filing date of August 8, 2002 of a German patent application, copy attached, Serial Number 102 36 381.1, filed on the aforementioned date, the entire contents of which are incorporated herein by reference.

Background of the Invention

Field of the Invention

Replace paragraph 0001 with the following paragraph and heading:

The present invention relates to a linear measuring device for measuring the relative position of a first machine element with respect to a second machine element. The first machine element is a base of a machine tool, for example, and the second machine element is the machine carriage which can be displaced with respect to the base.

### **Description of the Related Art**

Replace paragraph 0004 with the following heading and paragraph:

### **SUMMARY AND OBJECTS OF THE INVENTION**

It is therefore an ~~the~~ object of the present invention to disclose a linear

measuring device wherein the housing, together with the scale arranged in it, can be aligned parallel with the machine guidance device in a simple manner.

Replace paragraph 0005 with the following paragraph:

In accordance with the present invention, this object is attained by ~~a means of~~ the linear measuring device for measuring a relative position of a first machine element with respect to a second machine element. The device includes a housing fastened to the first machine element and a scale within the housing, wherein the scale is fastened extending along the housing in a measuring direction. A scanning device for scanning a scale. A linear guide device including a guide rail, which is rigidly assigned to the housing and includes a guide area; and a guide carriage, which supports the scanning device and is guided on the guide rail along the housing in the measuring direction, wherein the guide carriage is connected to the guide rail, free of play in all directions perpendicular to the measuring direction and the guide carriage includes a fastener to fasten the guide carriage rigidly on the second machine element in the measuring direction and the all directions perpendicular to the measuring direction. The housing is structured so that during measuring operations it is deflected perpendicular to the measuring direction at least in the guide area, so that in the course of movement of the guide carriage in a direction perpendicular to the measuring direction the housing is taken along in the direction perpendicular to the measuring direction having the characteristics of claim 1.

Delete paragraph 0006.

Replace paragraph 0007 with the following paragraph:

The present invention will be explained in greater detail by ~~means of~~ the drawings, wherein:

Replace paragraph 0008 with the following heading and paragraph:

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 represents an exemplary embodiment of a linear measuring device in longitudinal section[,] in accordance with the present invention;

Replace paragraph 0009 with the following paragraph:

FIG. 2 is a cross-sectional view of ~~cross-section II—II through the~~ linear measuring device in accordance with FIG. 1[,] taken along line II-II of FIG.1;

Replace paragraph 0010 with the following paragraph:

FIG. 3 is a cross-sectional view of ~~cross-section through~~ of a second embodiment of a linear measuring device in accordance with the present invention wherein the linear measuring device of FIG. 1 has been altered to include ~~with a~~ transmitted light scanning device[,];

Replace paragraph 0011 with the following paragraph:

FIG. 4 is a cross-sectional view of ~~cross-section through~~ of a third embodiment of a linear measuring device in accordance with the present invention wherein the linear measuring device of either FIG. 1 or FIG. 3 has been altered to include ~~with a~~ modified linear guide device[,];

Replace paragraph 0012 with the following paragraph:

FIG. 5 is a fourth embodiment of a linear measuring device in accordance with the present invention wherein ~~with a~~ protective tape as the covering is used with the linear measuring devices of FIGS. 1, 3 and 4;[,]

Replace paragraph 0013 with the following paragraph:

FIG. 6 is a fifth embodiment of a linear measuring device in longitudinal section with a scanning device outside of the housing[,] in accordance with the present invention;

Replace paragraph 0014 with the following paragraph:

FIG. 7 is a cross-sectional view of cross-section VII—VII through the linear measuring device in accordance with FIG. 6[,] taken along line VII-VII of FIG.6;

Replace paragraph 0015 with the following paragraph:

FIG. 8 is a cross-sectional view of cross-section through of a sixth embodiment of a linear measuring device in accordance with the present invention wherein the linear measuring device in accordance with FIG. 6 has been altered to include with a modified housing[,] and

Replace paragraph 0016 with the following paragraph:

FIG. 9 is a basic representation of a seventh embodiment of a linear measuring device in accordance with the present invention wherein the linear measuring devices of FIGS. 1, 3, 4-6 and 8 have been altered so that their ~~with a housing of housing~~ have a low flexural strength.

Replace paragraph 0017 with the following heading and paragraph:

#### DESCRIPTION OF THE PREFERRED EMBODIMENT(S) OF THE INVENTION

Encapsulated linear measuring devices will be described by ~~means of~~ FIGS. 1 to 5, wherein a scale 1, as well as a scanning device 2, are protectively arranged in the interior of a housing 3.

Replace paragraph 0018 with the following paragraph:

The linear measuring device in accordance with FIGS. 1 and 2 ~~consists of~~ includes a housing 3, resistant to bending and having a circular-cylindrical circumferential area made, for example, of aluminum, plastic or steel. The scale 1 is fixed in place on the housing 3 by ~~means of~~ a support 4.

Replace paragraph 0019 with the following paragraph:

For position measuring, the housing 3 is fastened by ~~means of~~ mounting elements 5, 6 on a first machine element 7, whose position in relation to a second

machine element 8 is to be measured. The design of the mounting elements 5, 6 will be described later in greater detail.

Replace paragraph 0020 with the following paragraph:

For position measuring, a guide carriage 10 is fastened on the second machine element 8 with fasteners ~~fastening means~~ 9 – in particular screws -, on which the scanning device 2 for scanning the scale 1 is fastened in turn. Fastening of the guide carriage 10 on the second machine element 8 takes place rigidly in the measuring direction X and in all directions Y, Z, perpendicularly with respect to the measuring direction X.

Replace paragraph 0021 with the following paragraph:

The guide carriage 10 embraces the housing 3 on all sides, and the circumferential face of the housing constitutes a guide rail 31, along which the guide carriage 10 is guided, free of play, in the measuring direction X. The guide carriage 10 is connected to the housing 3, free of play in all directions Y, Z perpendicular with respect to the measuring direction X, by ~~means of a~~ spherical bushing 11. Other rolling guide devices, or also sliding guide devices, can be used in place of the spherical bushing 11.

Replace paragraph 0023 with the following paragraph:

In the course of a position measurement, the guide carriage 10 is moved by the second machine element 8 in the measuring direction X, wherein the movement path is fixed by the machine guide element 12, which is only schematically represented in FIG. 1. The rigid connection in the measuring direction X, and in all directions perpendicular with respect thereto, of the guide carriage 10 to the second machine element ~~8~~ 12 assures an error-free transmission of this movement to the scanning device 2 rigidly connected to the guide carriage 10. Moreover, the guidance, free of

play in all directions perpendicular with respect to the measuring direction X, of the guide carriage 10 on the housing 3 assures that the housing 3, and therefore the scale 1, takes up a defined position with respect to the machine guide element 12. It is therefore not absolutely necessary for the housing 3 to be installed parallel with the machine guide element 12 in a highly accurate manner. In case of a faulty alignment, the guide carriage 10 assures that the housing 3 is taken along, and therefore a correct alignment perpendicularly with respect to the measuring direction X.

Replace paragraph 0024 with the following paragraph:

To assure this alignment during measuring operations, the rigid housing 3 is fastened on the first machine element 7 by ~~means of~~ at least one mounting element 5, which has connectors ~~means~~ 51 for the movable connection of the housing 3 in directions Y, Z perpendicularly with respect to the measuring direction X. These connectors ~~51 means~~ can be elastic elements 51 between the mounting element 5, which can be rigidly screwed to the first machine element 7, and the housing 3, wherein these elastic elements simultaneously can constitute a seal between the housing 3 and the mounting element 5.

Replace paragraph 0026 with the following paragraph:

The scale 1 is a steel tape, which has been adhesively fastened by ~~means of~~ an oil layer 100 or other viscous or elastic intermediate layer on the support 4, such as described in DE 196 11 983. However, a glass scale can also be employed. The scale 1 is rigidly fastened at a location in the measuring direction X on the housing 3 and/or on the mounting element 6 for forming a fixed point.

Replace paragraph 0029 with the following paragraph:

In place of incident light scanning represented in FIGS. 1 and 2 by ~~means of~~ a reflecting measuring structure 110, the employment of a scale 200 is also possible,

which can be scanned by ~~means of~~ a transmitted light scanning process, such as represented in FIG. 3. In this case the scale 200 has again been fastened on the housing 3 via a support, or directly, and the scanning device 2 is placed protectively in the interior of the housing 3. On one side of the scale 200, the scanning device 2 has a light source 21, and on the other side of the scale 200 a light-sensitive detector 22. The housing 3 is slit, and this slit 23 is sealed by ~~means of~~ an elastic seal 24, through which protrudes a sword-shaped connector 25, which rigidly connects the scanning device 2 with the guide carriage 10 in all directions X, Y, Z.

Replace paragraph 0033 with the following paragraph:

The housing ~~3~~ 2 is tube-shaped and has a circular-cylindrical circumferential area 31. The scale 1, which can be scanned opto-electrically, is fastened in the interior of the housing 3 and preferably is a linearly rigid pre-curved steel tape, matched to the curvature of the inner wall 32, if required, and is fastened, adhering directly to the inner wall 32 of the housing 3 via an oil film 100. The measuring structure 110 of the scale 1 is scanned by the scanning device 2, which is fastened on the second machine element 8, rigid in all directions X, Y, Z, by ~~means of~~ the guide carriage 10. For scanning through the housing 3, the latter is transparent to the scanning light beam, at least in the circumferential scanning area A. Thus, the housing 3 can be embodied to be transparent over the entire circumference or, as represented in FIG. 8, can be transparent only partially in that, for example, a transparent segment 310 is inserted into a steel segment 320.

Replace paragraph 0035 with the following paragraph:

The housing 3, for example a glass tube – in particular a viscoplastic glass tube or a plastic tube, is embodied to be rigid and is fastened on the first machine element 7 by ~~means of~~ the mounting elements 5, 6. Both mounting elements 5, 6 maintain the

housing 3 so it can be deflected perpendicularly with respect to the measuring direction X. The scale 1 is fastened, rigid in the measuring direction X, on a mounting element 6 for its definite fixation on the first machine element 7, to which end a spring wire 61 is again used, or a rod with joints, spaced apart in particular in the measuring direction X, in the form of weakened points.

Replace paragraph 0036 with the following paragraph:

For compensating an erroneous alignment between the machine guide element 12 and the scale 1 during measuring operations, a further step in accordance with the present invention is also advantageous. In this case the connectors ~~connecting means~~ 51, 61 between the rigid housing 3 and the mounting elements 5, 6 are constituted by the housing 30 itself in that the latter is designed to have low flexural strength. This embodiment is represented in principle in FIG. 9.

Replace paragraph 0037 with the following paragraph:

The guide rail is again constituted by the exterior face 31 of the housing 30 itself. It is alternatively possible to rigidly assign its own guide rail of low flexural strength to the housing 30. Again, the guide carriage 10 has been connected with the guide rail 31, free of play in the directions Y, Z perpendicularly with respect to the measuring direction X. The housing 30 advantageously has a circular-cylindrical circumferential area 31, which is embraced on all sides by the guide carriage 10 and wherein the circumferential area is used as the guide area 31. The guide carriage 10 has been connected with the guide rail 31, free of play in the directions Y, Z perpendicularly with respect to the measuring direction X. The scanning device 2 is rigidly fastened on the guide carriage 10, and the latter is fastened in turn on the second machine element 3, again rigid in all directions X, Y, Z. It is assured by ~~means of the~~ housing 30 ~~20~~ of low flexural strength, which for example can be made of plastic, that



during measuring operations it can be deflected perpendicularly with respect to the measuring direction X, at least in the guide area, and therefore in the scanning area, so that in the course of a movement of the guide carriage 10 perpendicularly with respect to the measuring direction X, the housing 30 is taken along in this direction. One of the housing ends can be rigidly fastened on the first machine element 7 by means of a mounting element 6, and the other end can be fastened, linearly movable, on the first machine element 7 by means of a further mounting element 5.

After paragraph 0039 insert the following paragraph:

Further embodiment variations of the method in accordance with the present invention of course exist besides the explained example.

Replace the paragraph beginning at page 8, line 1, with the following paragraph:

Claims I Claim:

After page 10 add a new page 11 to read as follows:

#### Abstract of the Disclosure

A linear measuring device including a housing fastened to a first machine element and a scale within the housing, wherein the scale is fastened extending along the housing in a measuring direction. A scanning device for scanning a scale. A linear guide device including a guide rail, which is rigidly assigned to the housing; and a guide carriage, which is guided on the guide rail along the housing in the measuring direction, and includes a fastener to fasten the guide carriage rigidly on a second machine element. The housing is structured so that during measuring operations it is deflected perpendicular to the measuring direction, so that in the course of movement of the guide carriage in a direction perpendicular to the measuring direction the housing is taken along in the direction perpendicular to the measuring direction.